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AN EXPERIMENT WITH A COURSE IN GENERAL TECHNOLOGY

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With the development of power machinery there came a new need in the educational world. Before the power machine arrived, production had been by hand-tool methods. But with the development of power, hand production rapidly gave way to machine production. The once simple process became more and more complex. And the machine, surrounded, as it came to be, by the four walls of a factory or a high board fence, no longer afforded the boy his one-time common privilege of observing industrial processes in operation or freely trying his hand at them.

To meet the needs of this changing situation, various types of industrial training were instituted, each with the more or less vague and indefinite aim of supplying in part the something from which the rising generations were rapidly being shut off. Although the kind of technical training that has been given has supplied many things of value in the life-training of the boy, never to any reasonable extent has it been adapted to boys in general or adequate to the needs of those who have availed themselves of it.

In view of the limited amount of time in a boy's high-school course which is available for technical training, manual training, as it is usually taught, has given too much time to special phases of a subject, while not really specializing in any true sense. Such courses have consumed the boy's time, limiting the range of technical subject-matter his course would cover and at the same time excluding, in many cases, other vitally important subjects from his school program.

A very large percentage of boys, because they have felt that the amount of time spent on these courses was excessive and that the limited scope and character of the content were not in keeping with their life-interests, have omitted entirely all technical subjects from their school training.

Not infrequently have the boys who have taken these courses gotten the impression that the product itself, rather than the knowledge and power to be acquired, was the all-important thing. Again, the tendency on the part of the boy has usually been to let someone do his thinking for him, though willingly working as best he could at the task that was laid out and assigned to him. The instructor, moreover, has too often accepted this attitude on the part of the pupil as a matter of course and has planned and conducted the classroom work in a manner to appeal to such interests. Naturally, the result of this type of teaching has been to obscure, rather than to emphasize, the true significance of technical training and to inhibit, rather than to stimulate, pupil initiative.

As a means of more nearly meeting the need of the average boy for technical knowledge and training, the experiment has been tried of providing such training through courses in general technology.

By the grouping of minimal essentials, by formulating units of study along the lines of, let us say (general technology) woodworking or (general technology) metal-working, and by a change in the methods of teaching, the attempt is made to bring early into the boy's experience a wide range of technical subject-matter, thereby contributing through this experience to the development of facility in problematic thinking and to the acquisition of skill in carrying forward typical constructive processes.

The educational objectives of a course of this type may be thought of in the following way:

I. INTELLECTUAL

1. Through a stimulation of interest, to encourage active thinking in terms of modern materials and conditions.
2. To promote the efficiency of organized effort.
3. To encourage refinement of muscular control and to fix a certain amount of skill in the manipulation of tools and materials.
4. To aid in the development of the ability to obtain information from the experience of others as expressed in the printed page.

II. SOCIAL

1. To give a wider range of contact with some of the basic materials and fundamental principles on which rests present-day civilization.

2. To promote a higher degree of respect for all classes who are engaged in doing the useful work of the world.

3. To give a useful knowledge of the more common machines and mechanical appliances with which the student comes in contact.

4. To afford basic experience and wider fields of information which will help the student in determining his abilities and his likes and dislikes when he is confronted with the necessity of choosing an occupation.

An example of such a course in (general technology) metal-working, the one offered in the University High School of the University of Chicago, is presented in outline form on page 606.

The method of presentation is by problematic question-lesson sheets. These consist of a series of questions intended to cause the pupil to study the important phases of a subject for himself. He is thereby led to seek information concerning the project from books on the subject, from duplicates of the projects or similar ones, and from the experience of others, the latter being permitted only after he has put forth reasonable effort or quite exhausted his own resources.

The general form and character of the assignments in this course may be illustrated by the typical lessons here submitted.

GENERAL TECHNOLOGY—METAL-WORKING

IRON

1. In what form is iron found in nature? In this form what percentage of it is iron? What constitutes the remainder?

2. How did iron come to accumulate in mines? What and where is Mesaba Range?

3. What geographic reasons made iron and steel manufacturing desirable in this region, as at Gary? In the cities along Lake Erie?

4. What is hematite? Where is it found? What is magnetite? Where found? Why is much of the magnetite of America not used? Why does that of Sweden excel?

5. Make a cross-sectional sketch of a smelting furnace. Explain briefly its operation.

SHOP II. GENERAL TECHNOLOGY—METAL-WORKING

Plan of Minimal Requirements and of Work for Excess Credit

Blocks of Instructional Material	Involves	Minimal Requirements	Excess Credit Zones	
			I	II
Common metals	Study of mining and smelting, transportation, ore regions, use of iron, tin, lead, zinc, copper, nickel, and properties of metals	Problems in identification, testing, and characterization		
Forging: mild steel or wrought iron	Operation of the forge. Use of hand tools. Drawing out, upsetting, bending, punching, shouldering, cutting, and riveting	Nails, rings, line cleats, gate hook, clevis, bracket, spout hook, hasp	Selected repair job at proper degree of difficulty	
Forging: welding and brazing	Determination of welding heats. Use of flux. Study of care of fire	Links, lap weld, brazed collar, brazing band-saw		
Forging: tool steel and tool making	Hand-tool forging, hardening and tempering. Study of methods of drawing tempers and manufacture of tool steel	Center punch, nail set, cold chisel, screw driver, scriber, hammer	Forging and tempering of high-speed steel	
Sheet metal work	Preparation of pitch for soldering. Study of joints. Use of soldering tools. Use of cleaning solutions	Making half-and-half solder, cleaning solution and swab, patching job, funnel, cubical box, pint cup		Advanced problem in development
Thread cutting	Use of standard taps and dies	$\frac{3}{4}$″ arbor or inside gauge collar with set screw. Ferrules $\frac{5}{8}$″, $\frac{3}{4}$″, $\frac{7}{8}$″, and 1″		
Engine lathe	Turning between centers. Study of mechanism of lathe. Chucking and use of chuck. Use of measuring tools	Threading bolts. Tapping nuts	Advanced problem in between-center turning or in chuck work	
Steam engine	Study of the engine, its parts, and their functions. Study of power transmission	Disassembling, assembling, and operating		
Gas engine	Study of the two- and four-cycle engines, their parts, and their functions	Disassembling, assembling, and operating		
Electric generator and motor	Study of direct and alternating currents. Application in motors and generators. Power transmission	Making an electro-magnet. Testing field coils and brushes. Making and measuring currents		Construction of a simple motor
Speed lathe—bench work	Use of wood-turning tools. Review in use of bench tools	Mallet handle, screw driver handle, tool tray		
Notebook: The work in this will be distributed throughout the above units	Drawing. Reading related material. Writing special reports. Answering questions of problem sheet	Drawings for projects. Illustrations of machines and their operation		Special reports or illustrations

6. Chemically, what is cast iron? What are the physical characteristics and industrial uses of cast iron?

7. Make a cross-sectional drawing of an open-hearth furnace. Explain briefly its operation.

8. What is wrought iron or mild steel? Name their physical characteristics and industrial uses.

9. Make a cross-sectional drawing of a Bessemer furnace. Explain briefly its operation.

10. How do different grades of tool steel differ? What are the physical characteristics and industrial uses of tool steel?

11. What is high-speed steel? How does it differ from common tool steel? Name several kinds of high-speed steel.

12. Describe briefly the crucible process for making steel.

13. What is the effect of sulphur in iron? Of phosphorus?

GENERAL TECHNOLOGY—METAL-WORKING

SHEET METAL AND METHODS OF WORKING IT

1. What is galvanized sheet iron?
2. What are some of the sizes these sheets come in?
3. Which is the heavier, No. 26 or No. 28 gauge?
4. How are sheet metals and wire measured?
5. What are sheet-metal worker's snips?
6. What is a lap joint? Make a small drawing to illustrate.
7. What is a lock joint? Illustrate.
8. What is a snap joint? Illustrate.
9. What is a butt joint? Illustrate.
10. What is meant by a turned edge? Illustrate.
11. What is meant by wiring? Illustrate.
12. What is a seaming tool used for? Illustrate.
13. What is a double seam?
14. What should be the shape of a small sheet metal punch?
15. What should the metal be laid on while being punched?
16. What kind of mark would you make on sheet metal to show where a hole is to be punched?
17. How is sheet tin prepared for soldering?
18. What uses are made of a scriber?

GENERAL TECHNOLOGY—METAL-WORKING

Make a tin cup of 1 pt. capacity, cup to be $3\frac{1}{2}''$ in diameter, $\frac{1}{8}$ lock seam, bottom to be double seam, top edge wired, cup handled.

1. Figure the dimensions of a pint cup, using $3\frac{1}{2}''$ as a diameter. How high must the cup be?

2. Make an object drawing of the cup showing the handle at the side.

3. Make an elevation drawing showing dimensions and construction.

4. What size sheet of tin will it take for the body of this cup, seams included?
5. What will be the diameter of the piece for the bottom?
6. What size wire should be used?
7. How should you find the proper length?
8. Should the wire be put in place before or after putting on the bottom? Why?
9. What should determine the size of a lock seam to be used on a job?
10. What precaution should be used in double seaming the bottom?
11. What form of stake should be used in double seaming the bottom?
12. How should you get dimensions and make the layout for the handle?
13. When should the handle be placed on the cup?
14. How should it be fastened to the cup?
15. What should be done to strengthen the handle?
16. After the job has been soldered, what should be done?

A freehand sketch of each project is required before the work of construction begins. Before any project can be undertaken, the drawing of the previous job and the answers to the question-lesson sheet must be entered in the notebook.

No so-called "exercise jobs" of any kind are given in any unit of study. In choosing the projects of the course an attempt has been made to select those that are practical and, wherever possible, related to other units of the course. For example, in forge work while the boy is learning the operation of shouldering with fulling tools, he is making a tap stock which he drills, files, polishes, and later uses in cutting threads. Again, he forges a bar of copper into a soldering point. It is then drilled, tapped, and a stem added. On the engine lathe he turns a metal ferrule; on the speed lathe, a handle. The parts are assembled. He next learns how to tin the point and uses his own soldering tool during his sheet-metal work.

In fact, in nearly every unit of study the boy finds that he is in need of some tool which he must provide for himself by his own effort. In his machine lathe work he is in need of calipers, a scriber, and a center punch which he makes. In his sheet-metal course he makes and uses his own soldering solution, half-and-half solder, a swab brush for spreading his soldering solution, a scriber, mallets, soldering tool, seaming tool, tinsmith's hammer, etc. Using his own tools creates an added interest in them and, it is assumed, will develop a feeling of responsibility for their care and proper use.

In each of the units of study it is intended to require the boy to go only far enough into the subject to give him some reasonable idea of its scope and possibilities and to acquaint him with the characteristics of the most essential materials and with the method of operating common machines and appliances. He is not, however, limited to the minimal essential. An outline of the entire course of study is posted in a convenient place on the wall of the shop room. Drawings or word pictures of all projects together with the question-lesson sheets are also posted. The pupil may go as deeply into any subject as time will permit. Furthermore, advanced units of work are provided by which it is possible to earn one- or two-tenths excess credit.

One of the principal criticisms of public-school training in general has been that far too large a percentage of the pupils cannot apply the knowledge they have gained. Not infrequently have we had pointed out to us that some of the men who have won large success in life have done so without school training. Of this class Edison is perhaps the best example. It would seem that long ago we should have learned from the life-experiences of such as he, and the success that has followed those who have taken correspondence-school courses, that the best method of teaching is to have the pupil dig things out for himself or "learn by doing." As Professor Leavitt has aptly phrased it, "A great many teachers should stop teaching and let the pupils learn."

By the method of presentation afforded in the problematic question-lesson sheet, the boy is brought face to face with problems in much the same manner that problems will confront him in later life, when there may be no one to show him how to proceed. He will then, perhaps, ask himself the questions involved in some such manner as they are asked in this course; and it is hoped that his experience here in working out his own solutions or finding the sources of the information required, will have prepared him in some measure to meet that situation.